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SHORT COMMUNICATION
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Influence of Different Obturation Systems on the Fracture Resistance of Endodontically Treated Roots

Efeito de diferentes sistemas de obturação na resistência à fratura de raízes tratadas endodonticamente

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ABSTRACT

Objective: This study aimed to compare the fracture resistance of endodontically treated roots filled by different obturation systems. **Material and methods:** Ninety-six maxillary central incisors were used and decoronated, retaining 12 mm of the roots. On the basis of obturation systems, the roots were randomly divided into 4 groups (n=24): Group1 (COGR): control group (unprepared, unfilled), Group 2 (AVGR): ActiV GP points/ActiV GP sealer, Group 3 (GPGR): Gutta percha points / AH plus sealer, and Group4 (GAGR): Gutta percha points/ActiV GP sealer. The last three groups were obturated with the single cone technique. The roots were then stored in 100% relative humidity at 37 °C for 2 weeks. A vertical compressive force was exerted in a universal testing machine until fracture occurred. Data were statistically analyzed using one-way ANOVA. **Results:** Mean (SD) failure loads for groups ranged from 920.51 ± 210.37 to 1113.44 ± 489.42 N. The fracture resistance between the different study groups indicated no statistical difference (p>0.05). **Conclusions:** ActiV GP system did not exert a significant effect on the fracture resistance of endodontically treated teeth.

KEYWORDS

ActiV GP; AH plus sealer; Endodontically treated teeth; Fracture resistance; Gutta percha.

RESUMO

Objective: Comparar a resistência à fratura de raízes tratadas endodonticamente obturadas através de diferentes sistemas. **Materiais e Métodos:** Noventa e seis incisivos centrais superiores foram utilizados, tiveram as coroas removidas, restando 12 mm de raíz. De acordo com o sistema de obturação, as raízes foram divididas em 4 grupos (n=24): Grupo1 (COGR): grupo controle (sem preparo, sem preenchimento), Grupo2 (AVGR): cones ActiV GP / cimento ActiV GP, Grupo3 (GPGR): cones de guta percha / cimento AH plus, e Grupo4 (GAGR): cones de guta percha / cimento ActiV GP. Os últimos três grupos foram obturados através da técnica de cone único. As raízes foram armazenadas em 100% de umidade relativa a 37 °C durante 2 semanas. Uma força compressiva vertical foi aplicada através de uma máquina de ensaio universal até ocorrer fratura. Os dados foram analisados estatisticamente através de ANOVA – 1 fator. **Resultados:** A carga média (SD) obtida no momento da falha variou entre 920.51 ± 210.37 até 1113.44 ± 489.42 N. A resistência à fratura entre os diferentes grupos estudados não indicaram diferença estatística. **Conclusão:** O sistema ActiV GP não exerceu um efeito significante na resistência à fratura em dentes tratados endodonticamente.

PALAVRAS-CHAVE

ActiV GP; cimento AH plus; Dentes endodonticamente tratados; Resistência à fratura; Gutta percha.

INTRODUCTION

Several factors can affect the fracture resistance of endodontically treated teeth (ETT), such as substance loss [1], preparation for access, presence of ferrule [1,2], shaping of root canal, dehydrating effects of irrigation solutions, long exposure to calcium hydroxide, excessive condensation during canal obturation, material and design of post and cores [3, 4], and preparation for final restoration [3,5,6]. Considering that gutta-percha does not provide the ideal bonding to root canal dentin, successive studies attempted to find alternative materials for creating a tight apical seal and supporting the root structure mechanically [7]. Glass ionomer cement (GIC) based sealers can adhere strongly to root canal walls but they cannot bind to gutta-percha cones (core material) namely, after complete setting, a space exists between the sealer and gutta-percha, allowing bacteria to pass through [8].

ActiV GP is a root canal obturation system comprising glass ionomer coated gutta percha cones that are bondable to intracanal dentin, depending on the glass ionomer (GI) sealer used [9]. The manufacturing company claimed that the product superior to previous GI-based filling materials in working time, handling characteristics and radiopacity [10]. Tay and Pashley classified ActiV GP as a tertiary monoblock system including three interfaces within the bulk material, core and the bonding substrate [11]. Many studies reported the superior bonding of ActiV GP to root canal walls [12,13]. Root canal instrumentation can weaken the root structure and predispose it to fracture [14]. Many factors should be considered when choosing the material to fill the root canal but in principle the material should be able to reinforce the tooth structure and strengthen it against fracture [15]. Reinforcing the remaining tooth structure after endodontic procedures is a major goal of root canal therapy [5]. The present study aimed to evaluate the ability of ActiV GP/GI sealer to increase the fracture resistance of endodontically treated roots (ETRs). The null hypothesis of the study was that the obturation system would not affect the fracture resistance of ETRs.

MATERIALS AND METHODS

Specimen preparation

Approval was first obtained from the local ethical committee. Ninety-six healthy and recently extracted upper central incisors were collected and stored in 10% formalin. All teeth were immersed in normal saline at 37°C until preparation. The teeth were then cleaned and examined under an optical microscope (BX60, Olympus, Tokyo, Japan) to exclude teeth with cracks, caries or open apices. All teeth were decoronated using a separating disk with a water spray, retaining 12 mm of the roots (figure 1).

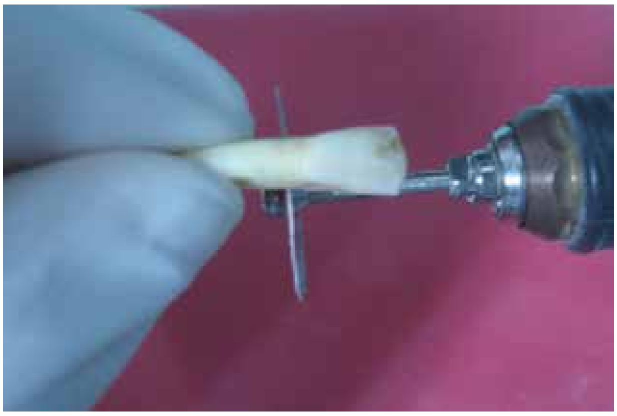

Figure 1 - Teeth were decoronated using a separating disk.

All apices of the teeth were sealed with a temporary filling material. The diameter of each root was recorded and all roots were randomly divided into 4 groups (n=24) according to the obturation system:

Group 1 (COGR): Roots were left unprepared and unfilled as a control group.

Group 2 (AVGR): ActiV GP points/ ActiV GP sealer (Brasseler USA, Savannah, GA, USA)

Group 3 (GPGR): Gutta percha points/ AH plus sealer (Dentsply DeTrey, Constance, Germany).

Group 4 (GAGR): Gutta percha points/ ActiV GP sealer.

Materials used in the obturation procedures are listed in Table 1. All roots, except control group, were accessed and the working length was set at 0.5 mm from the apex by inserting size 10 SS K File (Dentsply Maillefer, Ballaigues, Switzerland) with its tip seen at the apical foramen. The canals were then prepared using K3 rotary instruments (#0.06 Sybron-Endo, Orange County, CA, USA) to master apical file size 25. A 5.25% sodium hypochlorite (NaOCl) was used between the files. The smear layer was removed using 17% EDTA solution (MD cleanser, Meta Biomed Co, Incheon, Korea) for 1 min. All canals were then dried using paper points (Spident, Meta Biomed Co, Incheon, Korea). The last three groups were obturated by single cone technique using either ActiV GP cones (size 25) (Brasseler USA, Savannah, GA, USA) or gutta percha cones (size 25) (Figure 2). The coronal accesses of specimens were filled with a temporary filling material (Cavit, 3M ESPE, Seefeld, Germany). All teeth were stored at 37°C at 100% humidity for 2 weeks to allow the sealers to set completely.

Fracture resistance test

Root apical ends (4 mm) were vertically embedded into plastic boxes (13 mm in height and 15 mm in diameter) that were filled with a chemically polymerized acrylic resin (Vertex

Figure 2 - Root obturation.

Table 1 - Compositions of obturation & sealer materials used in this study

Material	Chemical Composition	Manufacturer
Gutta percha points	Matrix gutta percha: 20% filler zinc oxide: 66% radiopacifier heavy metal sulfates: 11% plasticizer waxes and/or resins: 3%	Meta Biomed Co., Cheongju City, Chungbuk, Korea
AH plus sealer	**Epoxide paste:** Diepoxide, Calcium tungstate, Zirconium oxide, Aerosil, Pigment **Amine paste:** 1-adamantane amine, N,N'-dibenzyl-5-oxa-nonandiamine-1,9 TCD-Diamine, Calcium tungstate Zirconium oxide, Aerosil, Silicone oil	Dentsply, Maillefer, Germany
ActiV GP points	Glass ionomer-coated gutta-percha	Brasseler USA, Savanah, GA, USA
ActiV GP sealer	**Powder:** Barium alimunasilicate glass powder, dried polyacrylic acid **Liquid:** Polyacrylic acid, tartaric acid	Brasseler USA, Savanah, GA, USA

Dental, Zeist, Netherland) leaving 8 mm of each root exposed [16]. The roots were placed at the middle of the acrylic tube. The temporary filling material was removed. The specimens were then mounted on the lower plate of the universal testing machine (Instron Corp, Canton, MA). The higher plate of the machine enclosed a cone-shaped rod (5 mm diameter metal rod), and compressive loading was applied directly over the canal opening of the roots with a loading rate of 1 mm per min until fracture occurred (Figure 3). The force needed to fracture every root was recorded in Newtons (N).

Statistical analysis

The data were analyzed using SPSS 18.0 (SPSS 18.0 for Windows, SPSS, Inc, Chicago, IL). Fracture resistance was expressed in mean and standard deviation for each group separately.

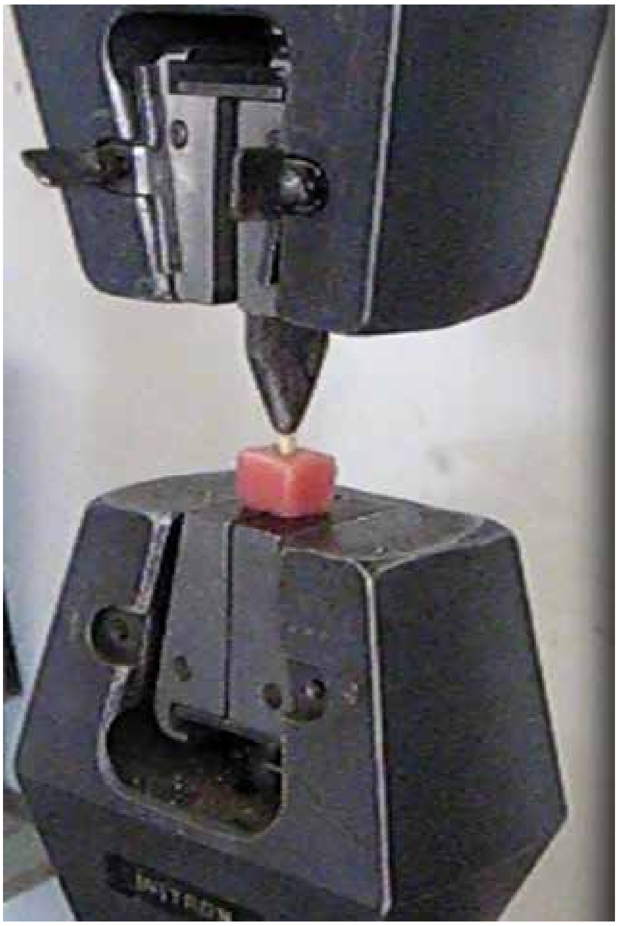

Figure 3 - Fracture strength test in the Universal Testing Machine

Statistical differences between groups were assessed using one-way ANOVA test. For all tests, a difference of α=0.05 was considered statistically significant.

RESULTS

The mean values of the fracture strength and standard deviations are displayed in Table 2. The highest mean of fracture resistance (1113.4 ± 489.4) was recorded for GPGR, while the lowest for AVGR (920.5 ± 210.4). Nevertheless, the groups did not indicate statistical difference (Table 3).

DISCUSSION

Although gutta percha has long been considered the standard endodontic filling material, it presents problems in preventing coronal leakage and reinforcing the ETT. These shortcomings have motivated many researchers to seek alternative materials and provide 3D seal for root canal systems [17]. Studies have evaluated the potential use of many root canal filling materials to reinforce ETT [14,18]. Given the scant research on ActiV GP/GI, the current study focused on evaluating the ability of this material. The study sample comprised 96 dental roots distributed equally into four groups. Single cone filling was applied to all groups except for COGR as this technique excludes both the wedging force of the spreaders during lateral condensation and the excessive dentin removal needed to facilitate the insertion of plugger during vertical condensation [19]. In order to simulate vertical fracture causing forces, compression forces were directed vertically on the tested roots mounted within acrylic blocks. This simulation technique is the most widely used in previous studies [8, 16]. Sagsen et al. applied force on the whole sectioned surface using a tip with a diameter of 4 mm [14]. In contrast, the tip used in the current study diameter was 5 mm in diameter since the average diameter of the roots was 5.3 mm. In this study, no statistical differences were noted

Table 2 - The mean fracture resistance and standard deviation (SD) for the studied groups represented in Newtons.

Obturation system groups	N	Mean	SD	Lowest mean	Highest mean
Activ GP cones + Activ GP sealer	24	920.51	210.37	588.6	1373.4
Gutta percha + AHplus	24	1113.44	489.42	490.5	2599.65
Gutta percha cones + Activ GP sealer	24	960.15	323.37	392.4	1667.7
Control group	24	1060.71	353.58	412.02	1726.56

Table 3 - ANOVA table for analysis of failure loads.

Source	Sum of Squares	df	Mean Square	F value	Sig.
Between Groups	569020.0	3	189673.3	1.478	0.226
Within Groups	11807648.2	92	128344.0		
Total	12376668.2	95			

df: degree of freedom

between the experimental groups. This finding concurred with Kazandag et al [20]. However, the result contradicted with that of Garcia and Caldeira [21], who declared superiority of ActiV GP over other filling materials (Gutta percha, AH filling paste, Thermafill, Real Seal, and Guttaflow). Garcia and Caldeira used only premolars and applied intracanal pressure using a finger spreader [21]. Our results could be explained in light of Lee et al., Tagger et al., and Timpawat et al., where low adherence between Ketac-Endo and root dentin was noted [22-24]. A similar result was reported by Gee et al. upon comparing GI and AH sealers [25]. GI sealer, particularly the GI-based Ketac-Endo, is the most dissolute paste among many pastes, as Ribeiro et al. confirmed in their study [26]. GI-based pastes are more prone to setting dimensional changes that possibly cause gaps between the cement and tooth structures [26]. In comparison, gutta percha and AH plus exhibited higher average of fracture resistance over the other groups in the present study. This finding could be attributed to their inherently high adherence and low solubility.

Using only a single load in the fracture test might have restricted the study. In order to mimic intraoral situations, additional studies should be conducted through thermocycling and dynamic fatigue loading.

CONCLUSION

Within the limitations of this study, using ActiV/GP as a root canal filling did not affect the fracture resistance of endodontically treated roots when used in conjunction with Glass ionomer sealer.

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The authors deny any conflicts of interest.

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